MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019 / 2020

PEL0016 - ELECTRICITY AND MAGNETISM

(Foundation in Engineering)

04 MARCH 2020
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **SIX (6)** printed pages including the cover page and appendices, with **FOUR (4)** questions.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

QUESTION 1 (15 marks)

a) A proton with a velocity of 3.5×10^6 m s^{-1} is moving through a uniform magnetic field of magnitude of 8.8×10^2 T. The direction of velocity and the magnetic field are shown in **Figure Q1 (a)**.

i) Calculate the magnetic force, ***F*** experienced by the proton [2 marks]

ii) Determine the direction of the magnetic force experienced by the proton. [1 mark]

iii) If the moving charge is changed to electron, determine the magnetic force direction. [1 mark]

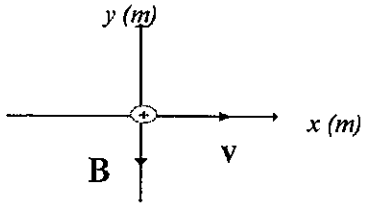

Figure Q1 (a)

b) Two parallel wires carrying a current of 10 A where both currents directed into the page are located at the corners of an **equilateral** triangle shown in **Figure Q1 (b).**

i) Draw again **Figure Q1 (b)** and sketch the magnetic field, B exerted on **P** due to the other two parallel wires. [2 marks]

ii) Calculate the magnitude of net magnetic field, B exerted on **P.** [5 marks]

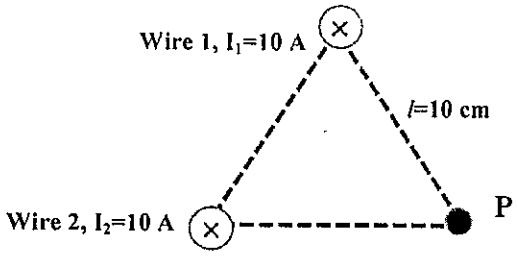

Figure Q1 (b)

c) From the Lenz law, determine the direction of the induced current. Sketch again **Figure Q1 (c)** and label the induced current accordingly for each circular loops. [4 marks]

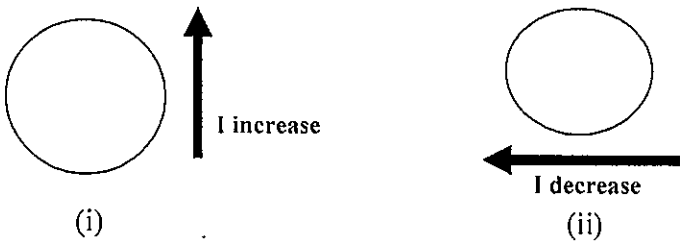

Figure Q1 (c)

Continued...

QUESTION 2 (15 marks)

a) Calculate the equivalent resistance between terminals *a* and *b* for each combination in **Figure Q2 (a).** [8 marks]

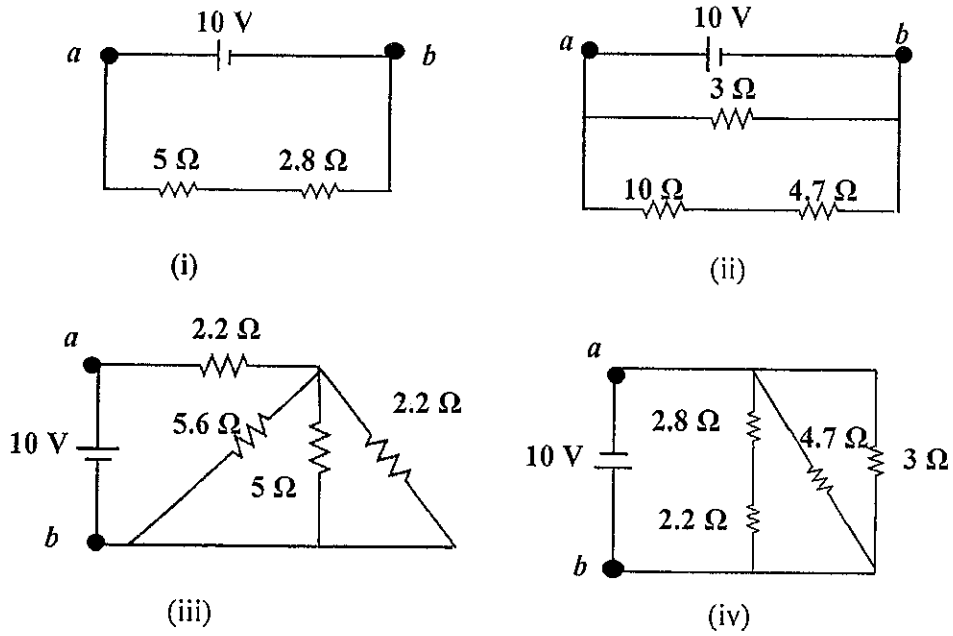

Figure Q2 (a)

b) Use Kirchhoff's Laws to calculate the magnitude of the current flowing in each resistor, I_1, I_2 and I_3 as shown in **Figure Q2 (b).** [7 marks]

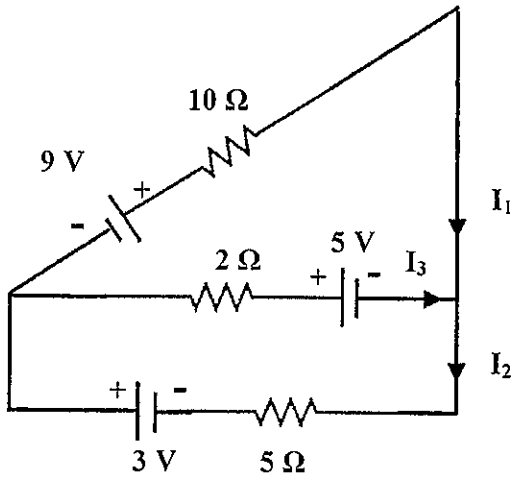

Figure Q2 (b)

Continued...

QUESTION 3 (10 marks)

A series R-L-C circuit of 60 Ω resistor, 200 μF capacitor and 111.41 mH inductance are connected to an AC generator with a frequency of 60 Hz and an rms voltage of 24 V.

i) Determine the inductive reactance, X_L. [1.5 marks]

ii) Determine the capacitive reactance, X_C. [1.5 marks]

iii) Determine the impedance in the circuit. [1.5 marks]

iv) Determine the r.m.s current passing through the inductor? [1.5 marks]

v) Determine the r.m.s voltage passing through the inductor? [1.5 marks]

vi) Draw the phasor diagram to show the relationship between the voltage and the current in the circuit. [2.5 marks]

QUESTION 4 (10 marks)

a) Explain how the depletion region is formed in a PN junction with the aid of a diagram. [2 marks]

b) Define what is the P-type semiconductor? [2 marks]

c) **Figure Q4 (c)** shows an amplification circuit using a silicon bipolar-junction transistor (BJT) operating in the common-emitter configuration. The voltage at base with respect to emitter terminal is V_{BE} = 0.7 V. If the direct current gain of the transistor is β_{DC} = 50, determine:

i) The base current, I_B, collector current, I_C and emitter current, I_E. [3 marks]

ii) The voltage at collector with respect to emitter, V_{CE} and voltage at the base, V_B [3 marks]

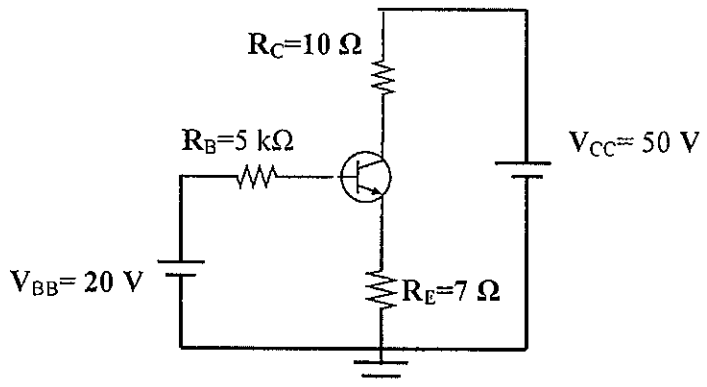

Figure Q4 (c)

APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_0	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_0	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2/C^2
Permittivity of free space	ε_0/κ_0	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:
One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 n I$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L\frac{dI}{dt}$$

$$\xi = -M\frac{dI}{dt}$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x}\right)I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_0 N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$P_t = I_{rms}V_{rms}\cos\phi$$

$$P_r = V_{rms}I_{rms}\sin\phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0\left[1 + \alpha(T - T_0)\right]$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA\sin\theta$$

$$U = \frac{1}{2}LI^2$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$V_H = Bvd$$

$$V = V_{max}\sin\omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T}\right)V_S$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B.dl = \mu_o I$$

$$d\mathbf{B} = \frac{\mu_0 I}{4\pi}\frac{d\ell \times \hat{\mathbf{r}}}{r^2}$$

$$\Phi_B = BA\cos\theta$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$